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(54) Reporter gene construct for the detection of HIV rev and HIV tat

(57) The present invention relates to a reporter gene construct for the detection of the HIV Rev and HIV Tat proteins. Furthermore, the invention relates to a functionality test method for Rev and Rev fusion proteins prepared in a recombinant manner, a method of screening for sequences of different origin for their activity as an instability element, a method of screening for sequences which cause the transport out of the nucleus into the cytoplasm by binding to cellular or other viral shuttle proteins, as well as to a method for the detection of HIV-infected cells. The reporter gene construct according to the present invention, after it has been introduced into cells, in the presence of HIV Rev and HIV Tat proteins results in the formation of reporter proteins which may be used for quantitative/qualitative detection of the HIV Rev and HIV Tat proteins.

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Description

[0001] The present invention relates to a reporter gene construct for the detection of the HIV Rev and HIV Tat proteins. Furthermore, the invention relates to a functionality test method for Rev and Rev fusion proteins prepared by recombinant DNA technology, a method of screening for sequences of different origin for their activity as an instability element, a method of screening for those sequences causing transport out of the nucleus into the cytoplasm by binding to cellular or other viral shuttle proteins as well as to a method for the detection of HIV-infected cells.

[0002] Rev and Tat are regulatory factors of the human immunodeficiency virus (HIV). They are among the first proteins to be synthesized in infected cells, and both are stimulators of HIV gene expression. The biological activity of Tat and Rev is important for the amount of virus production by infected cells. For example, the low HIV production which is characteristic for human astrocytes is associated with a 10time decreased activity of HIV Rev (Ludwig et al., 1999, J. Virol. **73**:8279-8289).

[0003] This importance mentioned above of Rev and Tat for the amount of virus production renders them particularly suitable for methods for the detection of HIV infection.

[0004] At present, there are two types of REV reporter systems which use either (1) HIV Gag proteins (e.g. vector pBR37R (Ludwig et al., 1999, J. Virol. **73**: 8279-8289)) or (2) a heterologous protein (e.g. chloramphenicol acetyl transferase = CAT; pDM128, Hope T.J. et al., 1990) as a reporter for Rev activity. In both systems the Rev reporter protein is detected in an indirect manner, i.e. either by means of antibody-ELISA (Gag, CAT) or, in the case of pDM128, by a functional CAT test. Both reporter proteins are detected in lysates of transfected cells for which several thousands of transfected cells must be employed.

[0005] The main disadvantages of the "gag-ELISA" are the relatively high efforts with respect to time and materials, the requirement of cell lysis (no further use of the cell population is possible), and the high costs (the techniques used so far are based on detecting Rev activity by the so-called "batch" method (antigen detection in the extract of lysed cells)).

[0006] So far, there have also been approaches which only detect the above-mentioned HIV Tat protein. Reporter gene constructs have been employed for this detection which for example express green fluorescent protein under the control of HIV LTR and thus in a Tat-dependent (but Rev-independent) manner (see Dorsky et al., J Acquir Immune Defic Syndr Hum Retrovirol, 1996 Dec 1; 13(4):308-313 *Detection of HIV-I infection with a green fluoresceht protein reporter system*).

[0007] Therefore, with regard to the disadvantages cited above the object of the present invention is to provide a highly specific reporter gene construct which may be used to perform HIV Rev-and Tat-specific test assays using living cells on a single cell level in a quick and cost-effective manner.

[0008] This object has been achieved by the features indicated in the independent claims. Preferred embodiments of the invention are set forth in the dependent claims.

[0009] The invention enables the detection and quantification of the function of HIV Rev and Tat proteins in living cells on a single cell level. The test is based on a qualitative and quantitative evaluation, and possibly selection and further cultivation of Rev-containing cells by means of the expression of a reporter gene. To achieve this Rev-dependent expression of the fluorescent protein, a reporter plasmid is used which is introduced into the cells to be tested.

[0010] This reporter plasmid has the following elements in functional association:

a) a promoter;
b) a TAR (Tat activation response) element;
c) a reporter gene;
d) a HIV Rev responsive element (RRE);
e) a transcription termination signal and a polyadenylation signal.

[0011] The reporter construct according to the invention can be transferred into cells (for example by transfection, microinjection etc.), and the recipient cells are analyzed after a defined time period. This time period depends on the amount of vector, e.g. plasmid transferred, the cell type, and the amount of Tat and Rev proteins produced in the cells to be examined.

[0012] Since the presence of Tat in the cell is required to enable an efficient elongation of transcription, reasonable amounts of the reporter mRNA will only be produced in those cells which contain functional Tat. In the further course, functionally active Rev is required for the transport of the reporter mRNA into the cytoplasm which would otherwise be retained in the nucleus and would be degraded. Rev-dependence is enhanced if the reporter gene construct of the invention contains an instability element (INS) in the reporter mRNA. Only in the case of an efficient transport of the mRNA into the cytoplasm translation of the reporter gene will be apparent.

[0013] Not before both proteins Rev and Tat are present inside the cell in a functional form (as in the case of e.g. transfection of the respective expression plasmids, microinjection or transfection of the functional proteins) a strong expression of the reporter protein will be achieved. This may be documented and observed quickly and easily on single cell level and in cell populations using known procedures like fluorescence or laser scanning microscopy or flow cytometry.

[0014] An advantage of the newly developed reporter construct is its uncomplicated and cost-effective use (only one plasmid is necessary) by which almost any large number of cells may be subjected to screening. Another advantage is the fact that single cell analyses

may be performed. This is of particular importance for diagnostic detection of low amounts of infected cells in patients suffering from a HIV infection. For this purpose, the method of choice is fluorescence flow cytometry which also enables the selection and further cultivation of the selected cells.

[0015] By means of the invention it is possible for the first time to measure the activity of Rev in living cells on a single cell level in a quick and cost effective manner.

[0016] The present receptor construct contains all HIV elements causing expression dependence of Tat and Rev in association with a heterologous reporter. This serves to achieve a very high specificity for the activity of these HIV factors. In contrast to present Rev reporter systems (see above) a reporter protein (encoded by a reporter gene) is used which can either be detected itself or by the formation of respective non-toxic products in living cells and therefore enables directly the detection of the reporter. These reporter proteins include for example fluorescent proteins (e.g. with red, yellow, or blue fluorescence), or enzymes metabolizing a cellular dye, or briefly all proteins which may be detected without cell fixation on a single cell level via non-toxic products. As an example for enzymes metabolizing a cellular (or cell penetrating) dye, the enzymes beta-galactosidase, beta-glucuronidase and luciferase can be used. The use of such reporter proteins also contributes to an increase in specificity and enables a quicker and more cost-effective test procedure.

[0017] The term "promoter" as used in the claims and the specification is meant to include any transcriptional control unit capable of intitiating transcription and includes regulatory elements such as enhancers and other regions binding transcriptional control factors.

[0018] The reporter gene construct according to the present invention preferably contains instability elements (INSs). These instability elements, preferably derived from HIV RNA, inhibit expression in the absence of Rev. By incorporation of these INSs into the construct downstream of the reporter, maximal inhibition of reporter expression is achieved in the absence of Rev without effecting the translation of the reporter in the presence of Rev. Thus, due to the presence of INSs, the reporter systems shown an extremely low "background" without Rev. A detailed description of the INSs may be found in the publication by Schneider R. et al., Journal of Virology, July 1997, pages 4892-4903 which is incorporated hereby by reference in its entirety.

[0019] The INS is incorporated into the reporter construct downstream of the reporter gene sequence. If a termination sequence for protein synthesis (see below) is included in the construct directly following the reporter gene sequence, the INS will be incorporated between this termination sequence and the HIV Rev responsive element (RRE) (see also Fig. 3). According to the invention, one or more INSs may be included in the construct. By repetitive inclusion of INS sequences the "background" described above may be further minimized (in this respect, see also Fig. 3).

[0020] Furthermore, the reporter gene construct preferably also contains a termination signal for protein synthesis downstream of the reporter gene sequence.

[0021] According to a preferred embodiment, the instability element is derived from the genome of HIV, e. g. from the INS portions of the gag region of HIV, and may for example consist of bases No. 379-1424 of the HIV HXB2R genome (see also *Schneider et al.*, supra).

[0022] The reporter construct according to the invention finds use in a method for in vitro detection of HIV infected eukaryotic cells. In this method, the reporter gene construct according to the present invention is introduced into cells, the cells are harvested after a defined period of time, and eventually a determination of the presence/amount of the reporter protein will be carried out. As a defined period of time, a time interval of about 24 h has proven to be particularly advantageous. The cells, in which the inventive reporter gene construct is introduced in this case, are preferably living human cells, in which Rev and Tat are potentially expressed.

[0023] The reporter gene construct preferably encodes a fluorescent protein wherein the determination of the protein is carried out by means of fluorescence microscopy or FACS. Preferred proteins are well known fluorescent proteins like green fluorescent protein (for example, from *Aequoria victoria*) or red fluorescent protein from coral; or *Ds*Red obtained from Clontech. Any other variation of a fluorescent protein may be considered.

[0024] Moreover, the present invention provides a method of screening for gene sequences for their activity as an instability element or as Rev responsive element (RRE). In this method, a test sequence is substituted for the instability element or the Rev responsive element (RRE) of the inventive reporter gene construct, cells are transfected with this test reporter gene construct, and eventually the expression of the reporter gene is compared to the expression of the original reporter gene construct in the presence of Tat and Rev. The term test sequence, as used in the description and the claims, encompasses all gene sequences, which theoretically could positively influence the expression and/or synthesis of the reporter gene construct of the present invention. Those test sequences might be derived, for example, from the human genome or from viral genomes.

[0025] In practice, such a screening method might be performed by providing to sets of cells, wherein one set is transfected with the inventive (original) reporter gene construct, and the other is transfected with the test reporter gene construct. Afterwards, expression of the reporter gene is compared in both sets of cells. A comparable or even higher expression of the reporter gene in the cells transfected with the test reporter gene construct indicates that the test sequence, which has been substituted for the original Rev-responsive sequences (ARE) and/or INS might have a similar function.

[0026] On the other hand, a reporter construct lacking the ARE can be used to detect novel INS elements, by assaying for diminished production of the reporter protein when comparing with a similar construct lacking the INS or containing the INS in antisense orientation.

[0027] The reporter construct can also be used for functional screening of Rev or Tat mutants or identification of other proteins of cellular or viral origins with similar functions as Tat or Rev. Furthermore, it can be used to identify Tat-responsive promoters of cellular or viral orgin Furthermore, the present invention provides a method of screening for gene sequences which cause the transport out of the nucleus by binding to cellular or other viral shuttle proteins wherein the Rev responsive element of the reporter gene construct according to the invention is replaced by a test sequence and afterwards cells are transfected with this reporter gene construct, and the expression of this test reporter gene is compared to the expression of the original reporter gene construct in the presence of Tat and Rev.

[0028] If test sequences have been tested positive in the above described methods, this information is of importance for the understanding of regulatory and cell biological processes, the modulation of expression levels of transgenes for stable expression. A transgene in this context is defined as a gene (in form of a suitable gene construct), which has been transferred from one species to another.

[0029] Further, there is provided an expression vector containing a reporter gene construct according to the present invention, an eukaryotic or prokaryotic cell transformed by this expression vector as well as RNA produced by the transcription of one of the expression vectors according to the invention.

[0030] Representative examples of appropriate cells, in which the reporter gene construct is introduced in the above described methods (not including the method for HIV detection, which utilizes human cells) are including bacterial cells, such as Streptococci, Staphylococci, E. coli, Streptomyces and Bacillus subtilis cells; fungal cells, such as yeast cells and Aspergillus cells; insect cells such as Drosophila S2 and Spodoptera Sf9 cells; animal cells such as CHO, COS, HeLa, C127, 3T3, BHK, HEK 293 and Bowes melanoma cells; and plant cells.

[0031] A great variety of expression systems can be used, which incorporate the reporter gene construct, for instance, chromosomal, episomal and virus-derived systems, e.g., vectors derived from bacterial plasmids, from bacteriophage, from transposons, from yeast episomes, from insertion elements, from yeast chromosomal elements, from viruses such as baculoviruses, papova viruses, such as SV40, vaccinia viruses, adenoviruses, fowl pox viruses, pseudo-rabies viruses and retroviruses, and vectors derived from combinations thereof, such as those derived from plasmid and bacteriophage genetic elements, such as cosmids and phagemids. Generally, any system or vector which is able to maintain, propagate or express a polynucleotide to produce a polypeptide in a host may be used. The appropriate nucleotide sequence may be inserted into an expression system by any of a variety of well-known and routine techniques, such as, for example, those set forth in Sambrook et al., MOLECULAR CLONING, A LABORATORY MANUAL, 2nd Ed., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y. (1989).

[0032] Generally, introduction of the reporter gene construct into the above described cells can be effected by methods described in many standard laboratory manuals, such as Davis et al., Basic Methods in Molecular Biology (1986) and Sambrook et al., Molecular Cloning: A Laboratory Manual, (supra). Preferred such methods include, for instance, calcium phosphate transfection, DEAF-dextran mediated transfection, transvection, microinjection, cationic lipid-mediated transfection, electroporation, transduction, scrape loading, ballistic introduction or infection.

[0033] Finally, the present invention comprises a functionality test for Rev and Rev fusion proteins prepared in a recombinant manner wherein cells are transfected with a reporter gene construct according to the invention and wherein the cells are co-transfected with an expression plasmid, or the test is carried out in a cell line expressing Tat in a stable manner.

Description of the drawings:

[0034]

Fig. 1 shows a reporter gene construct according to the present invention.

Fig. 2 shows a diagram of the fluorimetric detection of the expression of the early HIV proteins Rev and Tat on a single cell level.

Fig. 3 shows a comparison of the plasmids pLRed, pLRedR, pLRedINSR, and pLRed2xINSR.

Fig. 4 shows the Rev-dependent expression of the reporter using pLRedINSR and pLRed2xINSR as examples.

[0035] Referring to an embodiment of the invention, Fig. 1 shows a reporter construct according to the invention which contains, together with the reporter gene, the RNA binding element for Rev (called ARE = Rev responsive element), and HIV RNA elements (so-called instability elements = INSs) inhibiting the expression in the absence of Rev. By incorporating these INSs into the system according to the invention downstream of the termination signal for the reporter, maximal inhibition of reporter expression in the absence of Rev is achieved without affecting reporter translation in the presence of Rev.

[0036] Into the present embodiment, a portion of the

HIV *gag* gene has been introduced in which several INSs have been identified so far (Schneider et al., 1997). In the reporter construct according to the present invention the INSs are localized outside of the regions encoding the reporter and therefore do not affect the synthesis of the reporter on a translational level.

[0037] The reporter construct depicted in Fig. 1 consists of the following elements:

5'-LTR: contains the transcriptional regulatory unit (promoter/enhancer) and, 3' of the mRNA start site, the TAR (Tat activation response element) to which the Tat HIV protein binds. Tat is required for efficient elongation of the mRNA transcripts

Red: Red fluorescent protein (in this case: *Ds*Red obtained form Clontech; any other variation of a fluorescent protein may be considered; however certain variations (green, red) are preferable for subsequent FACS analyses). Downstream of the gene sequence encoding the red fluorescent protein there are STOP codons (termination signals) so that the translation will always end at this point and *Ds*Red will be the only protein expressed observed in the assays (S1). The gene has been amplified from vector pDSRed1-N1 commercially available from CLONTECH.

P17/24: 1060 bp region derived form the gag portion of HIV (bases No. 379-1424 of the genome of HXB2R). The so-called INS regions contained therein render the mRNA unstable in the absence of Rev, i.e. inhibit the efficient transport of the mRNA into the cytoplasm by the machinery of the cell.

RRE: Rev responsive element; contains the binding site for the viral shuttle protein Rev thereby enabling it to transport the mRNA into the cytoplasm and prevent its degradation in the nucleus.

3'-LTR: End of transcription and mRNA polyadenylation signal

[0038] As depicted in Fig. 2, cells are transfected, microinjected etc. by means of the reporter construct according to the invention, and these cells are harvested and analyzed after a defined time point. This time point depends on the amount of plasmid transfected, the cell type, and the amount of Tat and Rev proteins in the cells to be examined. For typical cell culture experiments, a time interval of 24 h will be optimal.

[0039] Since the presence of Tat in the cell is required to enable an efficient elongation of transcription reasonable amounts of the reporter mRNA will only be produced in those cells which contain functional Tat.

[0040] In the further course, functionally active Rev is required for the transport of the reporter mRNA into the cytoplasm which would otherwise by retained in the nucleus due to the instability elements contained on the mRNA and be degraded. Only in the case of an efficient transport of the mRNA into the cytoplasm translation of the red fluorescent protein will be initiated.

[0041] Not before both proteins Rev and Tat are present inside the cell in a functional form (as in the case of e.g. transfection of the respective expression plasmids, microinjection or transfection of the functional proteins) a strong expression of the fluorescent protein will be achieved. This fluorescence may be documented and observed quickly and easily on a single cell level using a fluorescence microscope or a FACS.

[0042] Figure 4 shows a schematic representation of the Rev-dependence of two reporter constructs by means of FACS analysis. HeLa Tat cells were transfected with a reporter construct (upper FACS plots: pLRed-INSR; lower FACS plots: pLRed(2xINS)R) and each with a green fluorescent transfection control (left plots) and a green fluorescent Rev fusion protein (right plots). Cells which are strongly positive for expression of the red fluorescent reporter are localized high up in the right upper quadrant. Transfected cells which are positive only for the constitutively expressed transfection control are localized in the lower right quadrant. Untransfected cells are in the lower left quadrant. It is clearly seen that in the presence of Rev far more reporter protein is expressed and that the two constructs differ in their Rev-dependence (the construct of the lower plots is much more dependent on Rev).

Example:

[0043] In an experiment, HeLa cells were transfected with different combinations of the plasmids described and analyzed for the expression of fluorescent proteins.

[0044] HeLa cells were transfected with the constructs described and analyzed by means of FACS analysis:

FACS analysis:

[0045] For the analysis of the Tat- and Rev-dependent expression of the fluorescent reporters, HeLa and HeLaTat cells were used.

[0046] Cells were seeded into 60 mm culture dishes and transfected after 24 h with the reporter constructs and a transfection control (GFP), and with the reporter constructs together with an expression construct for a Rev-GFP fusion protein, respectively, using different methods. The method used was calcium phosphate coprecipitation (Cell Phect, Amersham Pharmacia) and FuGene (Roche). The results obtained were independent of the method used.

[0047] 24 hours following transfection the cells were harvested, resuspended in PBS and then subjected to FACS analysis (FACS plots: see Figures F1 and F2). The analyses were carried out using a Calibur FACS device and CellQuest software of Becton Dickinson com-

pany.

[0048] For the evaluation, between 20,000 and 100,000 cells of a healthy homogenous cell population were examined for their fluorescence. For this purpose, the green fluorescence of the transfection control and the Rev-GFP fusion protein, respectively, were plotted against the red fluorescence of the reporter protein in a 2D plot. For the evaluation, the number of green fluorescent cells showing a strong red fluorescence was determined. Repeated experiments showed that the expression of the reporter depends strongly (pLREdINSR) and extremely strongly (pLRed(2xINS)R), respectively, on the presence of Rev. In the case of the reporter pLRed(2xINS)R no unspecific background could be observed in the experiments performed.

[0049] As has also been demonstrated, the presence of Tat is a prerequisite for these experiments.

Claims

1. A reporter gene construct containing the following functionally linked elements:

   a) a promoter;
   b) a TAR (Tat activation response) element;
   c) a reporter gene;
   d) the Rev responsive element (RRE) of HIV;
   e) a transcription termination signal and a polyadenylation signal.

2. A reporter gene construct according to claim 1 further containing a protein synthesis termination signal downstream of the reporter gene sequence.

3. A reporter gene construct according to claim 1 or 2 further containing one or more instability elements (INSs) downstream of the reporter gene sequence or, if present, downstream of the termination signal of protein synthesis.

4. A reporter gene construct according to any of the preceding claims wherein the reporter gene encodes a fluorescent protein.

5. A reporter gene construct according to claim 4 wherein the reporter gene encodes a red fluorescent protein.

6. A reporter gene construct according to any of the preceding claims wherein the instability element is derived from a HIV genome.

7. A reporter gene construct according to claim 6 wherein the instability element consists of the INS portions of the gag region of HIV.

8. A reporter gene construct according to claim 7 wherein the instability element consists of bases No. 379-1424 of the genome of HIV HXB2R.

9. A method for the in vitro detection of HIV-infected eukaryotic cells wherein

   a) a reporter gene construct according to any of the claims 1-8 is introduced into the cells;
   b) the cells are harvested after a defined time period; and
   c) a determination of the presence/quantity of the reporter protein is carried out.

10. A method according to claim 9 wherein the reporter gene construct encodes a fluorescent protein, and wherein the protein determination is performed by means of fluorescence microscopy or FACS.

11. A method according to claim 9 or 10 wherein the defined time period is about 24 h.

12. A method of screening for gene sequences for their activity as an instability element wherein

    a) the instability element of the reporter gene construct according to any of claims 3-8 is replaced by a test sequence;
    b) this test reporter gene construct is introduced into cells;
    c) the expression of the reporter gene of the test reporter gene construct is compared to that of the reporter gene construct according to claim 3-8 in the presence of Tat and Rev.

13. A method of screening for gene sequences which cause the transport out of the nucleus by binding to cellular or other viral shuttle proteins wherein

    a) the Rev responsive element of the reporter gene construct according to claim 1-8 is replaced by a test sequence;
    b) this test reporter gene construct is introduced into cells;
    c) the expression of the reporter gene of the test reporter gene construct is compared to that of the reporter gene construct according to claim 1-8 in the presence of Tat and Rev.

14. An expression vector containing a reporter gene construct according to any of the claims 1-8.

15. An eukaryotic or prokaryotic cell transformed by an expression vector according to claim 14.

16. An RNA produced by transcription of any of the expression vectors according to claim 1-8.

17. A functionality test for Rev and Rev fusion proteins

prepared in a recombinant manner wherein

a) a reporter gene construct according to any of the claims 1-8 is introduced into cells;
b) the cells are co-transfected with a Tat expression plasmid, or
c) the test is carried out in a cell line expressing Tat in a stable manner, or
d) the test is carried out in the presence of recombinant Tat protein; and afterwards
c) the cells are harvested after a defined time period; and
f) the presence/quantity of the reporter protein is determined.

18. A method of screening for Rev or Tat mutants or identification of other proteins of cellular or viral origins with similar functions as Tat or Rev, wherein

a) the reporter gene construct of any of claims 1-8 is introduced into cells;
b) the expression of the reporter gene of the reporter gene construct in said cells in the presence of Tat and Rev is compared to that of the reporter gene construct in the presence of Rev or Tat mutants or said other proteins of cellular or viral origins with similar functions as Tat or Rev.

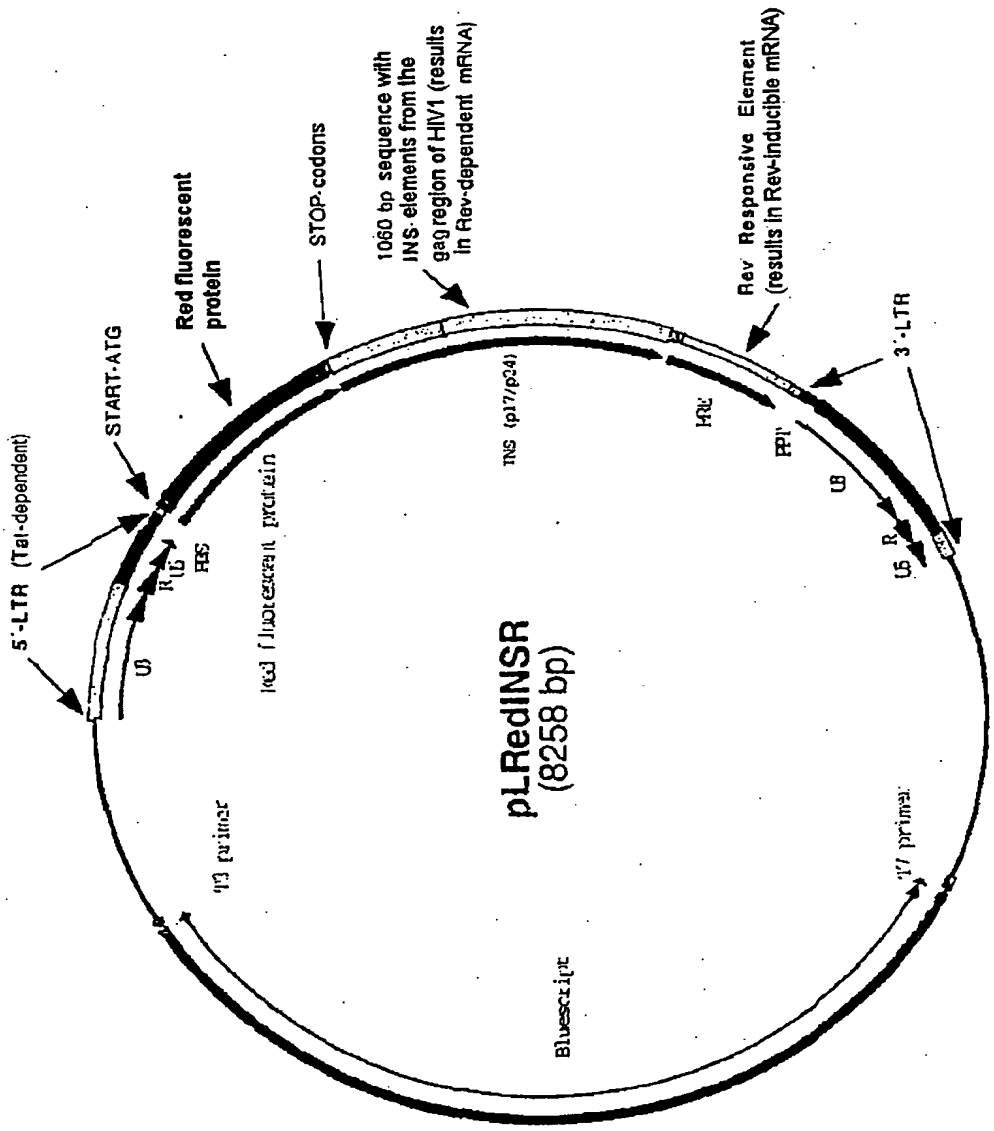


Figure 1: Reporter Construct

Figure 2: Fluorimetric detection of the expression of the early HIV proteins Rev and Tat on a single cell level

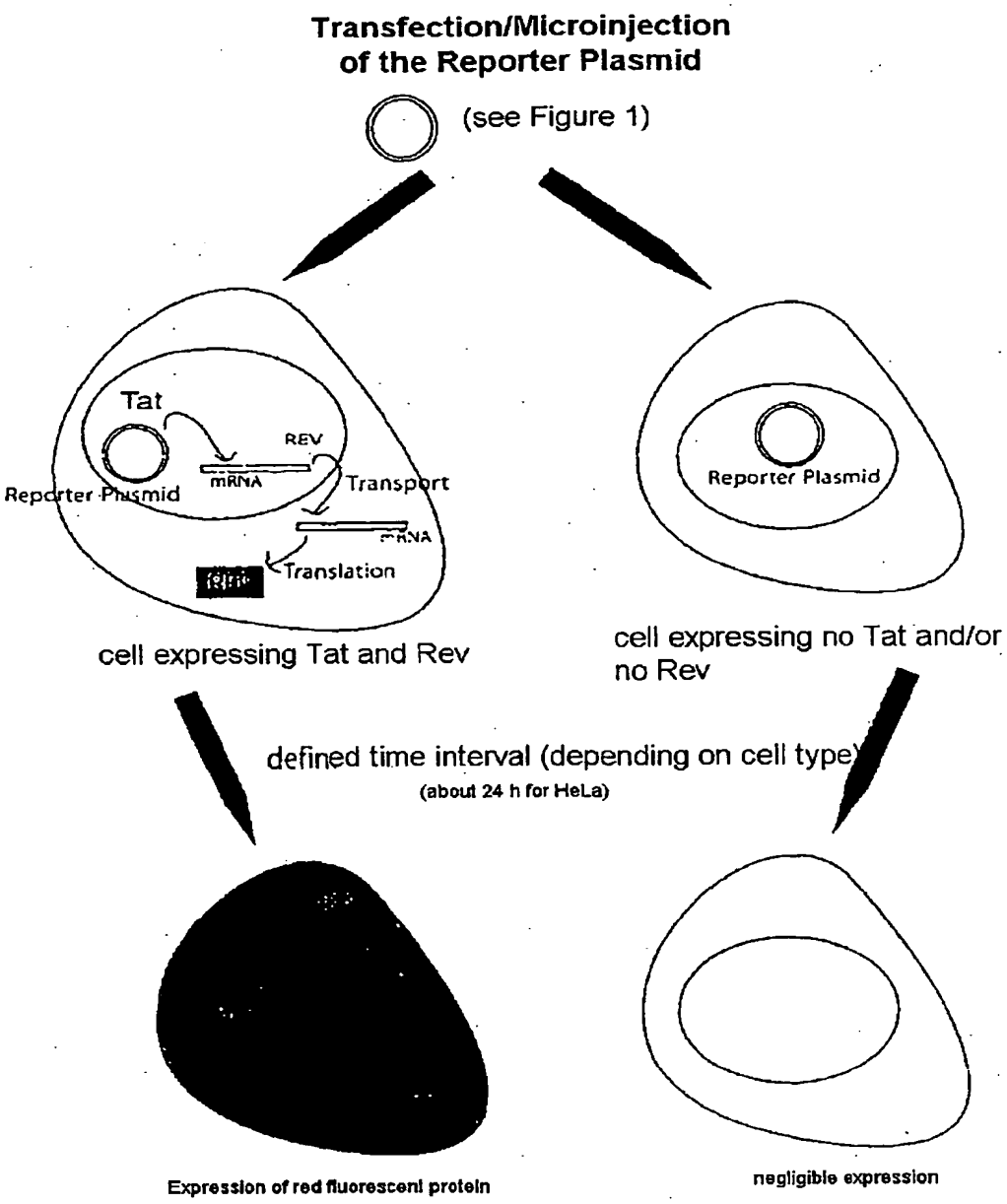
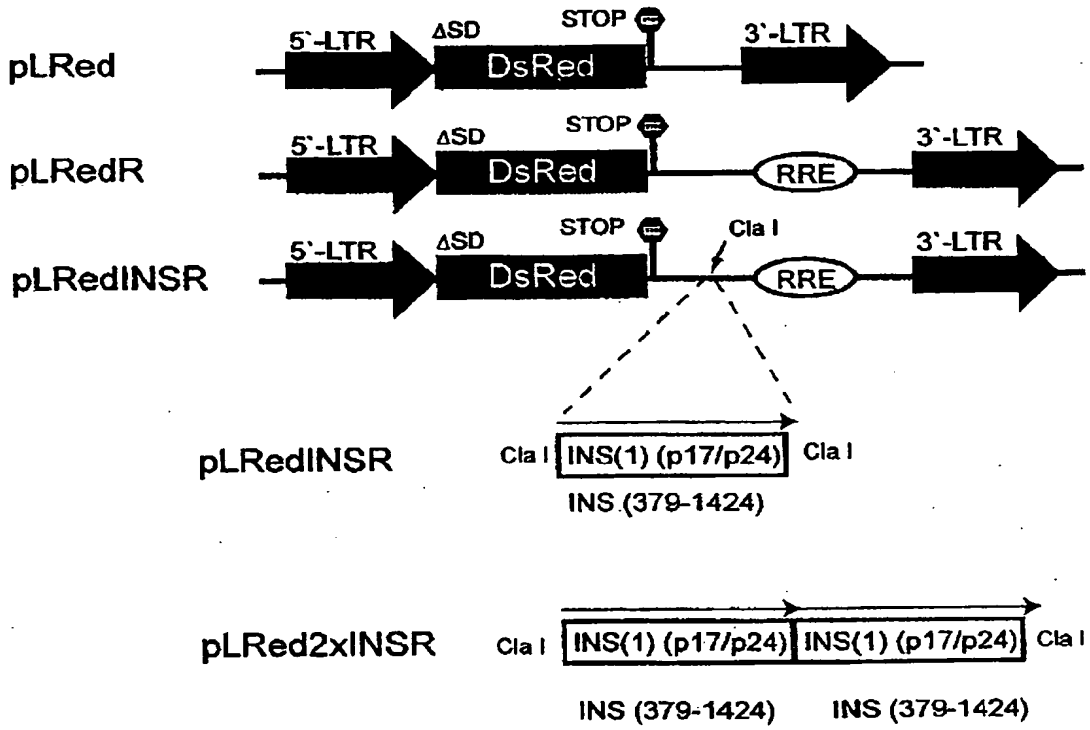


Figure 3 (plasmids)



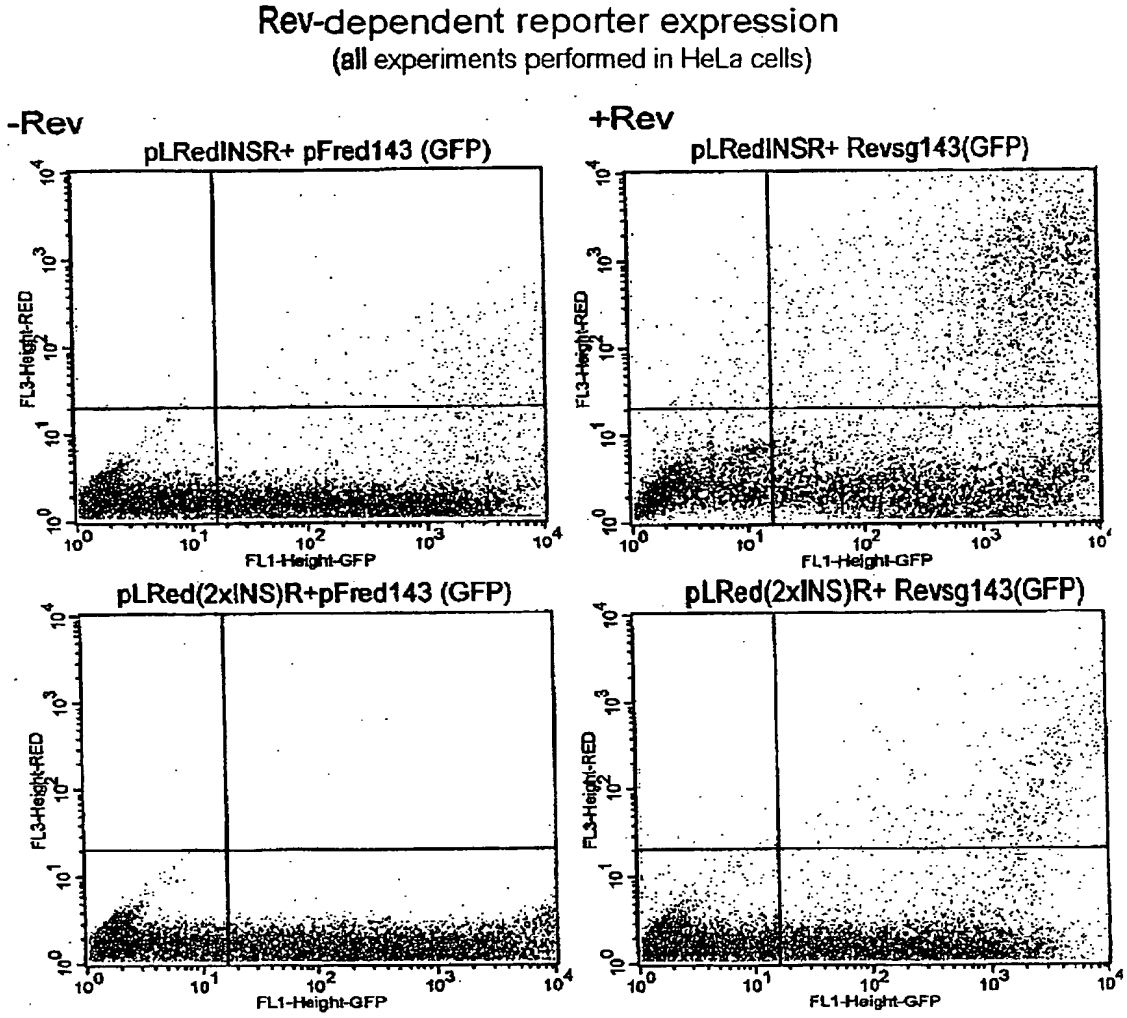


Fig. 4: the Rev-dependent expression of the reporter using pLRedINSR and pLRed2xINSR as examples.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 01 3820

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	POESCHLA E ET AL: "Development of HIV vectors for anti-HIV gene therapy." PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA. UNITED STATES 15 OCT 1996, vol. 93, no. 21, 15 October 1996 (1996-10-15); pages 11395-11399, XP000616290 ISSN: 0027-8424	1-4,6,7, 14-16	C12Q1/68 C12N15/86
Y	paragraph on "vectors" * page 11397 - page 11398 *	1-18	
X	HARRISON G S ET AL: "ACTIVATION OF A DIPHTERIA TOXIN A GENE BY EXPRESSION OF HUMAN IMMUNODEFICIENCY VIRUS-1 THAT AND REV PROTEINS IN TRANSFECTED CELLS" HUMAN GENE THERAPY, XX, XX, vol. 2, no. 1, 1991, pages 53-60, XP000651800 ISSN: 1043-0342	1,2, 14-16	
Y	* the whole document *	1-18	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Y	SCHNEIDER R ET AL: "Inactivation of the human immunodeficiency virus type 1 inhibitory elements allows rev-independent expression of gag and gag/protease and particle formation" JOURNAL OF VIROLOGY, THE AMERICAN SOCIETY FOR MICROBIOLOGY, US, vol. 71, no. 7, July 1997 (1997-07), pages 4892-4903, XP002137891 ISSN: 0022-538X * the whole document *	1-18	C12Q C12N

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	3 September 2002	Wimmer, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	DORSKY D I ET AL: "DETECTION OF HIV-1 INFECTION WITH A GREEN FLUORESCENT PROTEIN REPORTER SYSTEM" JOURNAL OF ACQUIRED IMMUNE DEFICIENCY SYNDROMES AND HUMAN RETROVIROLOGY, LIPPINCOT-RAVEN, XX, vol. 13, no. 4, 1 December 1996 (1996-12-01), pages 308-313, XP000915451 ISSN: 1077-9450 * the whole document *	1-18	
Y	GERVAIX ALAIN ET AL: "A new reporter cell line to monitor HIV infection and drug susceptibility in vitro." PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES, vol. 94, no. 9, 1997, pages 4653-4658, XP002142660 1997 ISSN: 0027-8424 * the whole document *	1-18	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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